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Benchmark Problems in Computational Aeroacoustics

by

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A recent directive at NASA Langley is aimed at numerically predicting principal noise sources. During my summer stay, I worked with high-order ENO code, developed by Dr. Harold Atkins, for solving the unsteady compressible Navier-Stokes equations, as it applies to computational aeroacoustics (CAA).

A CAA workshop, composed of six categories of benchmark problems, has been organized to test various numerical properties of code. My task was to determine the robustness of Atkins' code for these test problems. In one category, we tested the nonlinear wave propagation of the code for the one-dimensional Euler equations, with initial pressure, density, and velocity conditions. Using freestream boundary conditions, our results were plausible. In another category, we solved the linearized two-dimensional Euler equations to test the effectiveness of radiation boundary conditions. Here we utilized MAPLE to compute eigenvalues and eigenvectors of the Jacobian given variable and flux vectors. We experienced a minor problem with inflow and outflow boundary conditions. Next, we solved the quasi one-dimensional unsteady flow equations with an incoming acoustic wave of amplitude 10^{-6}. The small amplitude sound wave was incident on a convergent-divergent nozzle. After finding a steady-state solution and then marching forward, our solution indicated that after 30 periods the acoustic wave had dissipated (a period is time required for sound wave to traverse one end of nozzle to other end).